CLAIMS

1. A planarizing machine for mechanical or chemical-mechanical planarization of microelectronic-device substrate assemblies, comprising:

a table including a support surface having a first dimension extending along a pad travel path, a second dimension transverse to the first dimension, a planarizing zone within the first and second dimensions, and an optical opening at an illumination site in the planarizing zone;

a light source aligned with the illumination site to direct a light beam through the optical opening in the table;

a planarizing pad moveably coupled to the support surface of the table, the planarizing pad including a planarizing medium and at least one optically transmissive window along the pad travel path;

an advancing mechanism having an actuator system coupled to the planarizing pad and a position monitor coupled to the actuator system, the actuator system being configured to move the planarizing pad over the table along the pad travel path, and the position monitor being configured to sense the position of the window relative to the opening and to control the actuator when the window is aligned with the illumination site; and

a carrier assembly having a head for holding a substrate assembly and a drive assembly connected to the head to move the substrate assembly with respect to the planarizing pad.

2. The planarizing machine of claim 1 wherein the position monitor comprises an optical sensor configured to receive the light beam through the opening in the table when the window is at the illumination site.

3. The planarizing machine of claim 1 wherein:

the table further comprises a position monitoring site outside of the planarizing zone and spaced apart from the optical opening;

the planarizing pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path and a plurality of optical ports arranged in a second line spaced apart from the first line, the optical ports being configured relative to the windows so that one of the optical ports is located at the position monitoring site when a corresponding window is located at the illumination site; and

the position monitoring system comprises an optical sensor located to sense light passing through the one of the optical ports when a corresponding window is at the illumination site.

4. The planarizing machine of claim 1 wherein:

the table further comprises a position monitoring site outside of the planarizing zone and spaced apart from the optical opening;

the planarizing pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path and a plurality of optical ports arranged in a second line spaced apart from the first line, the optical ports being configured relative to the windows so that one of the optical ports is located at the position monitoring site when a corresponding window is located at the illumination site;

the position monitoring system comprises an optical sensor located to sense light passing through the one of the optical ports when a corresponding window is at the illumination site; and

the planarizing machine further includes a second light source configured to direct a second beam at the position monitoring site.

5. The planarizing machine of claim 1 wherein:

the table further comprises a position monitoring site outside of the planarizing zone and spaced apart from the optical opening;

the planarizing pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path and a plurality of contour elements arranged in a second line spaced apart from the first

line, the contour elements being configured relative to the windows so that one of the contour elements is located at the position monitoring site when a corresponding window is located at the illumination site; and

the position monitoring system comprises a displacement sensor located to sense a surface of the one of the contour elements when a corresponding window is at the illumination site.

6. The planarizing machine of claim 5 wherein the contour elements comprise a plurality of indents on a backside of the planarizing medium and the displacement sensor comprises a probe biased against the backside of the planarizing medium, the probe extending into an indent when a corresponding window is at the illumination site.

7. The planarizing machine of claim 5 wherein the contour elements comprise a plurality of notches along an edge of the planarizing pad and the displacement sensor comprises a pin, the notches being arranged so that one of the notches receives the pin when a corresponding window is at the illumination site.

8. The planarizing machine of claim 1 wherein:

the actuator system comprises a supply roller to hold a pre-operational portion of the planarizing pad, a take-up roller to hold a post-operational portion of the planarizing pad, and a motor coupled to the supply roller and/or the take-up roller; and

the position monitor comprises an optical sensor electrically coupled to the motor, the optical sensor being configured to receive the light beam from the light source when the window is at the illumination site, and the optical sensor generating a signal to stop the motor upon sensing the light beam.

9. The planarizing machine of claim 1 wherein:

the table further comprises a position monitoring site outside of the planarizing zone and spaced apart from the optical opening;

the actuator system comprises a supply roller to hold a pre-operational portion of the planarizing pad, a take-up roller to hold a post-operational portion of the planarizing pad, and a motor coupled to the supply roller and/or the take-up roller;

the planarizing pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path and a plurality of optical ports arranged in a second line spaced apart from the first line, the optical ports being configured relative to the windows so that one of the optical ports is located at the position monitoring site when a corresponding window is located at the illumination site; and

the position monitoring system comprises an optical sensor operatively coupled to the motor, the optical sensor being configured to sense light passing through the one of the optical ports when a corresponding window is at the illumination site, and the optical sensor generating a signal to stop the motor upon sensing the light.

10. The planarizing machine of claim 1 wherein:

the pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel with the pad travel path and a plurality of conductive features on a surface of the pad, the conductive features being arranged along a second line relative to the windows so that a conductive feature is a fixed distance from a corresponding window; and

the position monitor comprises first and second electrical contacts space along the pad travel path relative to the opening by the fixed distance to engage one of the conductive features of the pad when a corresponding window is over the opening, at least one of the contacts being coupled to the actuator to deactivate the actuator when a conductive feature engages the contacts.

11. A planarizing machine for mechanical or chemical-mechanical planarization of microelectronic-device substrate assemblies, comprising:

a table including a support surface having a first dimension extending along a pad travel path, a second dimension transverse to the first dimension, a planarizing zone

within the first and second dimensions, and an optical opening at an illumination site in the planarizing zone;

a light source aligned with the illumination site to direct a light beam through the optical opening in the table;

a planarizing pad moveably coupled to the support surface of the table, the planarizing pad including a planarizing medium and at least one optically transmissive window along the pad travel path;

an advancing mechanism having a supply member to hold a first portion of the pad, a take-up member to hold a second portion of the pad, and an actuator coupled to the supply member and/or the take-up member to move the planarizing pad over the table along the pad travel path;

a position monitor having a sensor coupled to the actuator, the sensor generating a signal when the window is aligned with the illumination site to control the actuator; and

a carrier assembly having a head for holding a substrate assembly and a drive assembly connected to the head to move the substrate assembly with respect to the planarizing pad.

12. The planarizing machine of claim 11 wherein the position monitor comprises an optical sensor configured to receive the light beam through the opening in the table when the window is at the illumination site.

13. The planarizing machine of claim 11 wherein:

the table further comprises a position monitoring site outside of the planarizing zone and spaced apart from the optical opening;

the planarizing pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path and a plurality of optical ports arranged in a second line spaced apart from the first line, the optical ports being configured relative to the windows so that one of the optical ports is located at the position monitoring site when a corresponding window is located at the illumination site; and

the position monitoring system comprises an optical sensor located to sense light passing through the one of the optical ports when a corresponding window is at the illumination site.

14. The planarizing machine of claim 11 wherein:

the table further comprises a position monitoring site outside of the planarizing zone and spaced apart from the optical opening;

the planarizing pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path and a plurality of optical ports arranged in a second line spaced apart from the first line, the optical ports being configured relative to the windows so that one of the optical ports is located at the position monitoring site when a corresponding window is located at the illumination site;

the position monitoring system comprises an optical sensor located to sense light passing through the one of the optical ports when a corresponding window is at the illumination site; and

the planarizing machine further includes a second light source configured to direct a second beam at the position monitoring site.

15. The planarizing machine of claim 11 wherein:

the table further comprises a position monitoring site outside of the planarizing zone and spaced apart from the optical opening;

the planarizing pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path and a plurality of contour elements arranged in a second line spaced apart from the first line, the contour elements being configured relative to the windows so that one of the contour elements is located at the position monitoring site when a corresponding window is located at the illumination site; and

the position monitoring system comprises a displacement sensor located to sense a surface of the one of the contour elements when a corresponding window is at the illumination site.

16. The planarizing machine of claim 11 wherein:

the pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel with the pad travel path and a plurality of conductive features on a surface of the pad, the conductive features being arranged along a second line relative to the windows so that a conductive feature is a fixed distance from a corresponding window; and

the position monitor comprises first and second electrical contacts space along the pad travel path relative to the opening by the fixed distance to engage one of the conductive features of the pad when a corresponding window is over the opening, at least one of the contacts being coupled to the actuator to deactivate the actuator when a conductive feature engages the contacts.

17. A planarizing machine for mechanical or chemical-mechanical planarization of microelectronic-device substrate assemblies, comprising:

a table including a support surface having a first dimension extending along a pad travel path, a second dimension transverse to the first dimension, a planarizing zone within the first and second dimensions, and an optical opening at an illumination site in the planarizing zone;

a light source aligned with the illumination site to direct a light beam through the optical opening in the table;

a planarizing pad moveably coupled to the support surface of the table, the planarizing pad including a planarizing medium and at least one optically transmissive window along the pad travel path;

an advancing mechanism having an actuator system coupled to the planarizing pad and a position monitor, the actuator system being configured to move the planarizing pad over the table along the pad travel path, and the position monitor having an optical sensor coupled to the actuator system to control the actuator system according to a sensed light intensity; and

a carrier assembly having a head for holding a substrate assembly and a drive assembly connected to the head to move the substrate assembly with respect to the planarizing pad.

18. The planarizing machine of claim 17 wherein:

the table further comprises a position monitoring site outside of the planarizing zone and spaced apart from the optical opening;

the planarizing pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path and a plurality of optical ports arranged in a second line spaced apart from the first line, the optical ports being configured relative to the windows so that one of the optical ports is located at the position monitoring site when a corresponding window is located at the illumination site; and

the position monitoring system comprises an optical sensor located to sense light passing through the one of the optical ports when a corresponding window is at the illumination site.

19. The planarizing machine of claim 17 wherein:

the table further comprises a position monitoring site outside of the planarizing zone and spaced apart from the optical opening;

the planarizing pad further comprises a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path and a plurality of optical ports arranged in a second line spaced apart from the first line, the optical ports being configured relative to the windows so that one of the optical ports is located at the position monitoring site when a corresponding window is located at the illumination site;

the position monitoring system comprises an optical sensor located to sense light passing through the one of the optical ports when a corresponding window is at the illumination site; and

the planarizing machine further includes a second light source configured to direct a second beam at the position monitoring site.

20. A planarizing machine for mechanical or chemical-mechanical planarization of microelectronic-device substrate assemblies, comprising:

a table including a support surface having a first dimension extending along a pad travel path, a second dimension transverse to the first dimension, a planarizing zone within the first and second dimensions, at least a first optical opening at an illumination site in the planarizing zone, and a position monitoring site;

a first light source aligned with the illumination site to direct a first light beam through the optical opening in the table;

a second light source aligned with the position monitoring site to direct a second light beam at the position monitoring site;

a planarizing pad moveably coupled to the support surface of the table, the planarizing pad including a planarizing medium, at least one optically transmissive window along the pad travel path, and an optical port located relative to the window to be at the position monitoring site when the window is at the first optical opening;

an advancing mechanism having an actuator system coupled to the planarizing pad and a position monitor, the actuator system being configured to move the planarizing pad over the table along the pad travel path, and the position monitor having an optical sensor coupled to the actuator system and aligned with the position monitoring site to receive the second light beam when the optical port is at the position monitoring site; and

a carrier assembly having a head for holding a substrate assembly and a drive assembly connected to the head to move the substrate assembly with respect to the planarizing pad.

21. A planarizing machine for mechanical or chemical-mechanical planarization of microelectronic-device substrate assemblies, comprising:

a table including a support surface having a first dimension extending along a pad travel path, a second dimension transverse to the first dimension, a planarizing zone within the first and second dimensions, an optical opening at an illumination site in the planarizing zone, and a position monitoring site;

a light source aligned with the illumination site to direct a light beam through the optical opening in the table;

a planarizing pad moveably coupled to the support surface of the table, the planarizing pad including a planarizing medium, at least one optically transmissive window along the pad travel path, and a contour element located relative to the window to be at the position monitoring site when the window is at the illumination site;

an advancing mechanism having an actuator system coupled to the planarizing pad and a position monitor, the actuator system being configured to move the planarizing pad over the table along the pad travel path, and the position monitor having a displacement sensor coupled to the actuator system and located at the position monitoring site to engage the contour element when the window is at the illumination site; and

a carrier assembly having a head for holding a substrate assembly and a drive assembly connected to the head to move the substrate assembly with respect to the planarizing pad.

22. The planarizing machine of claim 21 wherein the contour elements comprise a plurality of indents on a backside of the planarizing medium and the displacement sensor comprises a probe biased against the backside of the planarizing medium, the probe extending into an indent when a corresponding window is at the illumination site.

23. The planarizing machine of claim 21 wherein the contour elements comprise a plurality of notches along an edge of the planarizing pad and the displacement sensor comprises a pin, the notches being arranged so that one of the notches receives the pin when a corresponding window is at the illumination site.

24. A planarizing pad for mechanical and/or chemical-mechanical planarization of a microelectronic-device substrate assembly, comprising:

a planarizing medium having a planarizing surface with a planarizing zone defining a contact area for the substrate assembly;

at least one optically transmissive window through the planarizing medium, the window being in the planarizing zone; and

an optical port through the planarizing medium, the port being outside of the planarizing zone.

25. The pad of claim 24 wherein the optical port comprises a hole through the pad.

26. The pad of claim 24 wherein the optical port comprises a notch along an edge of the pad.

27. The pad of claim 24, further comprising:

a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path; and

a plurality of optical ports arranged in a second line spaced apart from the first line.

28. The pad of claim 27 wherein the optical ports comprise holes through the pad.

29. The pad of claim 27 wherein the optical ports comprise notches along an edge of the pad.

30. A planarizing pad for mechanical and/or chemical-mechanical planarization of a microelectronic-device substrate assembly, comprising:

a planarizing medium having a planarizing surface with a planarizing zone defining a contact area for the substrate assembly;

at least one optically transmissive window through the planarizing medium, the window being in the planarizing zone; and

a contour element having a surface defining a discrete change in contour of at least one of a backside or an edge of the planarizing medium.

31. The pad of claim 30 wherein the contour element comprises an indent on the backside of the pad.

32. The pad of claim 30 further comprising:

a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path; and

a plurality of contour elements arranged in a second line spaced apart from the first line.

33. The pad of claim 32 wherein the contour elements comprise a plurality of indents along the backside of the pad.

34. A planarizing pad for mechanical and/or chemical-mechanical planarization of a microelectronic-device substrate assembly, comprising:

a planarizing medium having a planarizing surface with a planarizing zone defining a contact area for the substrate assembly;

at least one optically transmissive window through the planarizing medium, the window being in the planarizing zone; and

a conductive feature on at least one of a backside or along an edge of the planarizing medium.

35. The pad of claim 34, further comprising:

a plurality of windows arranged in a first line aligned with the opening in the table in a direction generally parallel to the pad travel path; and

a plurality of conductive features arranged in a second line spaced apart from the first line.

36. The pad of claim 35 wherein the conductive features are arranged in a pattern along a backside of the planarizing medium.

37. A method for planarizing a microelectronic-device substrate assembly, comprising:

positioning an optically transmissive window in a planarizing pad in alignment with a first light beam of an endpointing system by moving the planarizing pad along a pad travel path, sensing when the window is aligned with the light beam, and stopping the planarizing pad from moving further along the pad travel path; and

removing material from a microelectronic-device substrate by pressing the substrate against a planarizing surface of the planarizing pad and moving the substrate and/or the planarizing pad in a planarizing plane.

38. The method of claim 37 wherein sensing when the window is aligned with the light beam comprises directing the light beam through the window to an optical sensor configured to receive the light beam when the window is aligned with the first light beam.

39. The method of claim 37 wherein sensing when the window is aligned with the light beam comprises detecting a reflection of ambient light from a position monitoring site on a table supporting the planarizing pad through an optical port in the pad, the port being spaced apart from the window.

40. The method of claim 37 wherein sensing when the window is aligned with the light beam comprises detecting a change in contour of the planarizing pad at a contour element spaced apart from the window.

41. The method of claim 40 wherein the contour element comprises an indent on a backside of the planarizing pad arranged to be at a position monitoring site on a table supporting the planarizing pad when the window is aligned with the beam, and detecting a change in contour of the planarizing pad comprises biasing a probe of a displacement sensor into the indent when the window is aligned with the beam.

42. The method of claim 40 wherein the contour element comprises a notch along an edge of the planarizing pad arranged to be at a position monitoring site on a table supporting the planarizing pad when the window is aligned with the beam, and detecting a change in contour of the planarizing pad comprises biasing a probe of a displacement sensor into the notch when the window is aligned with the beam.

43. The method of claim 37 wherein sensing when the window is aligned with the light beam comprises engaging a conductive feature on the planarizing pad with a first electrical contact and a second electrical contact to electrically deactivate an actuator coupled to the pad when the window is aligned with the beam.

44. A method of endpointing mechanical or chemical-mechanical planarization processing of microelectronic-device substrate assemblies, comprising:

initially passing a light beam from an illumination site in a table through a first optically transmissive window in a planarizing pad to at least periodically impinge a first substrate assembly with the light beam and optically sense a surface condition of the first substrate assembly;

advancing the planarizing pad relative to the table and the illumination site after planarizing the first substrate assembly;

stopping the advancement of the planarizing pad by sensing the light beam passing through a second optically transmissive window in the planarizing pad spaced apart from the first window in a direction generally parallel to the pad travel path; and

subsequently passing a light beam from the illumination site in the table through the second optically transmissive widow in the planarizing pad to at least periodically impinge a second substrate assembly with the light beam and optically sense a surface condition of the second substrate assembly.

45. The method of claim 45 wherein sensing the light beam comprises directing the light beam through the second window to an optical sensor configured to receive the light beam when the second window is aligned with the light beam.